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Depression of superconducting transition temperature due to Pr substitution in $(La_{2.5-x}Pr_xNd_{0.5})CaBa_3Cu_7O_z$ system

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Structural and superconducting properties of single-phase Pr-substituted compounds of the formula $(La_{2.5-x}Pr_xNd_{0.5})CaBa_3Cu_7O_z$($0 \leq x \leq 0.7$) have been investigated. Neutron diffraction studies reveal that these compounds crystallize in the triple perovskite structure(space group $P4/mmm$) with an oxygen cotnent of 16.6 per formula unit which is nearly independent of the Pr concentration. The compound with x=0 is superconducting with a transition temperature, T_c, of $\sim$ 79K. On partial substitution of Pr at the nominal La site, T_c is found to decrease almost linearly with x to 42K for x=0.7. In order to see if the depression of T_c, due to Pr, can be compensated by Ca, we have examined $(La_{2.5-x-y}Pr_xCa_yNd_{0.5})CaBa_3Cu_7O_z$ with Pr concentration, x=0.7 and Ca concentration, y=0.4. The observed T_c in this compound is almost independent of Ca concentration suggesting the absence of hole filling in the depression of T_c by Pr. The observed reduction of T_c with increasing Pr concentration in the title compound has been analysed on the basis of magnetic pair breaking by Pr-4f electrons. The 4f-electrons are presumed to hybridize with the conduction electrons leading to a large 4f - conduction electrons exchange interaction.